WISCONSIN CONSTRUCTION SPECIFICATION

203. GEOSYNTHETIC CLAY LINER (GCL)

1. SCOPE

The work shall consist of furnishing, transporting, and placing a geosynthetic clay liner (GCL) to the elevations, grades and cross sections as shown on the drawings or as staked in the field.

2. MATERIALS

The GCL shall consist of a layer of natural sodium bentonite clay encapsulated between two polypropylene textiles (geotextile), and shall comply with the criteria in Table 1.

For purposes of strength, performance, and integrity, the GCL shall be manufactured by mechanically bonding the geotextile using a needle-punching process. Needle-punched GCLs are those which, by the use of a needling board, have fibers of the non-woven geotextile pushed through the bentonite clay layer and integrated into a woven or non-woven geotextile.

The bentonite sealing compound or bentonite granules used to seal penetrations and make repairs shall be made of the same natural sodium bentonite as the GCL and shall be as recommended by the GCL Manufacturer.

All GCL shall be free of damage or defect. Each package delivered to the job site shall bear the name of the material, the Manufacturer's name or symbol, lot number and roll number, roll length and width, and the total roll weight of the material.

3. SHIPPING AND STORAGE

The GCL shall be transported to the job site in a manner not to damage the rolls. The liner rolls shall be stored so they are protected from puncture, dirt, grease, water, moisture, mechanical abrasion, excessive heat, ultraviolet light exposure, or other damage. The rolls shall be stored on a smooth surface (not wooden pallets). Rolls shall be stacked to a height no higher than the height which the lifting apparatus can be safely handled (typically no higher than four).

4. SUBGRADE PREPARATION

The area to be lined shall be drained and allowed to dry until the surface is firm. The subgrade surface must be firm, unyielding, and able to support people and equipment that must travel over it during installation of the GCL. All cut and fill slopes shall be constructed in accordance with the drawings. Required subgrade fill shall be placed in layers with a maximum thickness of 6 inches prior to compaction. The fill soils shall be disked or worked in such a manner as to obtain a maximum clod size of 4 inches prior to compaction. Each layer shall be compacted by a minimum of one pass over the entire surface of the fill by a fully-loaded rubber-tired scraper or a tamping roller. Operation of the compaction equipment will be continuous over the entire area during fill operations. Fill materials shall have a

moisture content sufficient to insure the required compaction is achieved. The adequacy of fill moisture content and compaction will be approved by the Technician.

The foundation area shall be smooth and free of projections that can damage the GCL. Stumps and roots shall be removed. Rocks (larger than 1/2" and all fractured rocks), hard clods, and other such material shall be removed, rolled with a smooth-wheeled vibratory roller, or covered with a compacted cushion of fine soil. No equipment tracks or footprint indentations shall be present in the subgrade.

An anchor trench for the liner shall be excavated and backfilled in accordance with the drawings. No loose soil shall be allowed at the bottom of the trench and no sharp corners or protrusions shall exist in the trench. Minimum trench dimensions shall be 18 inches deep and 12 inches wide.

5. PLACEMENT

The Contractor shall only deploy the amount of GCL in one working day as can be covered by earthen backfill or geomembrane. In no case shall the GCL be exposed to the elements at the end of the day.

The GCL rolls shall be deployed using a spreader bar assembly attached to a loader bucket or by other methods approved by the liner Manufacturer. The method chosen to unroll the panels shall not cause wrinkles, folds, or crimps in the GCL and shall not damage the supporting soil.

The GCL shall not be deployed during periods of heavy precipitation, in the presence of excessive winds, or in areas of ponded water.

GCL panels shall be placed with the non-woven geotextile side against the subgrade. On slope areas exceeding a steepness of 4H:1V, the long dimension of all panels shall go up and down the slope. Panels on flat areas require no particular orientation. Panels should be placed from the highest elevation to the lowest in the area to be lined to facilitate drainage in the event of precipitation. Panels shall be placed free of tension or stress yet without wrinkles or folds. It is not permissible to stretch the GCL in order to fit a designated area. Panels shall not be dragged across the subgrade into position except where necessary to obtain the correct overlap for adjacent panels.

The top edge of the liner shall be placed in the anchor trench and anchored with compacted backfill. Compact the backfill by wheel rolling with light rubber-tired equipment or a manually directed power tamper.

6. SEAMING

All GCL seams shall be formed by executing a bentonite enhanced overlap to ensure a continuous seal is achieved between panels.

A 6-inch to 9-inch side overlap shall exist at seam locations. The lap line and match lines printed on the liner panels shall be used to assist in obtaining this overlap. The edges of the GCL panels should be adjusted to smooth out any wrinkles, creases, or "fishmouths" in

order to maximize contact with the underlying panel. End laps shall be a minimum of 12 inches.

After the overlying panel is in place, its edge shall be pulled back to expose the overlap zone. Any soil or debris present in the overlap zone or entrapped in the geotextiles shall be removed. A fillet of granular bentonite shall then be poured in a continuous manner along the overlap zone (between the edge of the panel and the overlap line), at a rate of at least one-quarter pound per linear foot. The use of a watering can or line chalker is recommended to improve the uniformity and consistency of the bentonite fillet. This process shall be conducted in accordance with the Manufacturer's instructions.

If a geomembrane is used in conjunction with the GCL, the needle-punched GCL overlap seams shall be offset at least 5 feet from the overlying geomembrane seams.

The GCL shall be sealed around penetrations and embedded structures in accordance with the construction drawings and/or as specified by the Manufacturer.

7. REPAIRS

Any damage in the form of cuts or tears in the GCL shall be identified and repaired by the Contractor. A patch shall be cut from unused GCL such that the patch size extends 12 inches in all directions around the damaged area. Accessory bentonite shall be placed around the perimeter of the affected area at the rate of one-half pound per lineal foot prior to placement of the patch . An epoxy-based adhesive shall be used to keep the patch in position during backfill operations.

GCL will be removed and replaced if it is significantly hydrated prior to placement of overlying material (cover soil or geomembrane). The GCL shall be considered significantly hydrated when the liner is more that three-eighths inches thick or the moisture content of the bentonite is greater than 40% (ASTM D 4643).

8. PLACEMENT OF OVERLYING MATERIALS

Cover soils shall be mineral soil, free of angular stones or other foreign matter which could damage the GCL. Cover soils with high concentrations of calcium (e.g. limestone, dolomite) are not acceptable.

Soil cover shall be placed with low ground pressure equipment. The final thickness of soil cover shall be at least 1 foot over the GCL or as shown on the drawings. For high-traffic areas or roadways, a minimum of 2 feet is required. To prevent damage to the GCL, the initial lift(s) of soil cover shall not be compacted in excess of 85 percent of Modified Proctor density.

No vehicles should be driven directly on the GCL until the proper thickness of cover has been placed. Care should be taken to avoid damaging the GCL by making sharp turns or pivots with equipment.

When covering GCL installed on sloped areas steeper than 4H:1V, the soil cover shall be pushed upslope to minimize tension on the GCL.

If the cover material is a geomembrane or other geosynthetic, precautions shall be taken to prevent damage to the GCL by restricting heavy equipment traffic. Unrolling the geomembrane can be accomplished through the use of lightweight, rubber-tired equipment such as a 4-wheel all-terrain vehicle (ATV). This vehicle can be driven directly on the GCL, provided the ATV makes no sudden stops, starts, or turns.

The leading edge of GCL panels left uncovered at the end of the working day shall be protected with a waterproof sheet which is adequately secured with sandbags or other ballast.

9. LINER HYDRATION FOR MANURE CONTAINMENT FACILITIES

In installations where containment of manure, barnyard runoff, milking center wastes containing manure, etc., is required, the GCL must be hydrated with water prior to introducing the liquids containing manure.

The GCL on the bottom of the containment facility shall be hydrated by flooding or the use of a sprinkler system. Hydration of the side slopes shall be accomplished by the use of a sprinkler system if adequate rainfall is not anticipated prior to contact with the liquids containing manure.

10. FINAL TESTS AND INSPECTION

Upon completion of the work, the installation shall be subjected to a final inspection. All work in the system therein being tested shall be complete, cleaned and ready for use. The work shall meet the requirements as to the lines, grades, cleanliness and workmanship. Any discrepancies shall be repaired.

11. BASIS OF ACCEPTANCE

The acceptability of the geomembrane shall be determined by inspections to check compliance with all the provisions of this specification, with respect to the drawings, markings, the appurtenances, and the minimum installation requirements.

The installing Contractor shall certify that the materials and installation complies with the requirements of this specification.

TABLE 1
Requirements for Geosynthetic Clay Liner (GCL)

Material	Property	Test Method	Value[1]
Geotextile			
Woven	Mass/Area	ASTM D 3776	3.1 oz/sq yd
Non-woven	Mass/Area	ASTM D 3776	6.0 oz/sq yd
Bentonite[2]			
	Swell Index	ASTM D 5890	24 ml/2g min.
	Moisture Content	ASTM D 4653	12% max.
	Fluid Loss	ASTM D 5891	18 ml max.
Finished GCL			
	Bentonite Content[3] Mass/Area	ASTM D 5993	0.75 lb/sq ft
	Grab Strength	ASTM D 4632	
	Non-Woven/Non-Woven		150 lbs
	Non-Woven/Woven		90 lbs
	Grab Elongation	ASTM D 4632	75% Typ.
	Peel Strength	ASTM D 4632	15 lb min.
	Permeability[4]	ASTM D 5084	5×10^{-9} cm/sec max.
	Hydrated Internal Shear Strength[5]	ASTM D 5321 or D 6243	500 psf
	Index Flux	ASTM D 5887	1×10^{-8} $m^3/m^2/sec$

[1] All values, unless specified otherwise, are minimum average roll values (MARVs) as reported by the specified test methods.

[2] These parameters are for the bentonite as delivered to the GCL manufacturer, not for the bentonite in the finished product.

[3] Bentonite mass per unit area at 0% moisture content.

[4] At 5 psi confining pressure.

[5] Specimen hydrated for 24 hours and sheared at a 200 psf normal stress.